A PROJECT BASED APPROACH TO LEARNING FOR 1ST YEAR ENGINEERING STUDENTS

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ABSTRACT

Support for transition from Leaving Certificate and entry to college for 1st year engineering students can be difficult to achieve. This new course offers an innovative project based approach to learning for 1st years with an introduction to design to build confidence in student ability and give motivation in research and discovery skills. The project takes place in small groups and relies heavily on presentation, group and individual skills. The Mechanical and Manufacturing and the Electronic Engineering Schools at Dublin City University offered this new module for all first year Engineering Students in 2006. The course entitled, 'Project and Laboratory Skills' was an immediate success with increased participation and retention rates and a high level of academic success in assessment. This paper highlights the overall module concepts, teaching and learning outcomes and the resources required for such a module.

INTRODCUTION

1st year students must adapt quickly to university and develop a range of new professional and personal skills while adapting to unfamiliar surroundings and campus life. A number of institutions have introduced 1st year / freshman modules to assist with this transition [1, 2, 5]. Others have examined the needs of the engineering profession into the future and in particular the education standards required to meet these needs [4]. Project based learning has been highlighted as a key component in the transition of 1st year students to university based engineering degree courses [3]. A new module in the faculty of Engineering and Computing at DCU aims to support students in this transition while honing their skills in design, manufacture, assemble and presentation. The department is fortunate to have highly skilled technical, academic and support staff and a world class engineering workshop at its disposal. Students are encouraged to interact with staff through mentor meetings, weekly scheduled classes and informal meetings. They are also encouraged to problem solve for themselves and in groups and to design, simplify and modify their concepts through formal feedback. The class is taught and assessed in a number of ways to promote both individual contribution and team work. The bulk of this assessment is in groups of 4 which aids team work and presentation skills. Within 2 semesters each team must design and build a robot to compete in a soccer competition. Some of the design constraints and the parts supplied are outlined in table 1.

Design constraints	Parts List
❑ Robot size limited to A4 ❑ Only parts supplied to the group can be used (tools, materials and mechanical/electronic parts) ❑ Pitch size will be 4m * 3m ❑ Ball size will be that of a golf ball	❑ RC receiver ❑ Servo (2 required) steering/cupping ball ❑ Solenoid for kicking ball ❑ Various Components and Material ❑ Motor Speed Controller

Table 1: Project Design Constraints and Project Parts lists

PROJECT STRUCTURE AND ASSESSMENT

The class (currently 120 students), is divided into teams of 4 and these teams cycle through a range of activities in semester 1 and 2. These activities are timed to impart specific skill sets at various points throughout the semester to aid completion of the project in week 10 of the second semester. The activities include the following

Semester 1 structure and events

1. Mechanical Workshop Skills (Weeks 1-6): Each student has to manufacture a metal aeroplane from a given set of detailed drawings. The aim of this task is to introduce students to a range of workshop skills including reading of engineering drawings, marking up of engineering components, drilling, cutting, filing and tapping of parts and assembly of finished components. This is an individual task and the students are assessed on their ability to manufacture to specific guidelines, ability to manage their time and of course the finished product. Support and feedback from academic and technical staff is offered along the way and formal assessment and marks give in week 6.

2. Mechanical Drawing (weeks 1-12): Through the entire first semester students are required to attend formal studio work related to drawing of engineering components. These are 3 hour drawing classes per week and introduce student to the art of graphical communication. A deliberate decision was taken to exclude the use of CAD packages in the 1st semester to encourage students to develop manual drafting skills and to develop accuracy and neatness in relation to drawing presentation. This drawing course is then backed up with CAD software in the second semester when student realise the effort required to product a quality engineering drawing.

3. Electronic Design (weeks 7-12): Following completion of the workshop skills course in week 6 students move on to a range of electronic's skills classes. These include soldering, PCB board assembly and E-CAD labs for circuit design. Each of these courses last two weeks and result in students designing, building and testing electronic circuits.

4. Labs, Lectures and Presentations (weeks 1-12). Throughout the first semester students are required to attend labs sessions (including materials labs, electronic labs and drawing classes as mentioned above). They are also given lectures on design, concept development and presentation skills. Concepts for their design project (in this case a robot to compete in a soccer competition) are assessed in week 6 and three concepts are encouraged for this formal presentation. Feedback is offered

on the concepts and students are encouraged to modify their final design before proceeding to develop detailed drawings of this final design by the end of semester 1.

Figure 1: Semester 2 Robot Build

Figure 2: Poster Presentation

Semester 2 structure and events:

1. Build Phase (weeks 1-10). During this build phase students must build their final design selected from a number of concepts presented during semester 1. The team work from detailed drawings and must devise a work plan and assign tasks to various members of the team. Technical support and guidance is offered throughout this build phase which take place in a well equipped engineering workshop (Figure 1).

2. Labs, Lectures and Presentations (weeks 1-12). The build phase is backed up with a series of labs (including thermo-fluids, electronic fundamentals and mechanics). A lecture slot is included in the timetable to allow course coordinators to address the class as a whole when required. Formal lectures are also given on design and assembly methods, electronics and on topics such as recycling, ethics and sustainable design. Each team is required to design a poster for a presentation of their work to the public in week 10 (Figure 2). These presentations take place in the foyer of the engineering building to encourage questions for a diverse audience.

3. Event and Assessment (week 10-12). Each team must compete in a soccer match in week 11. The first part of this event assesses how well each individual design functions. A golf ball is places in 5 strategic positions on a custom built football pitch. The team must demonstrate that their design can manoeuvre to the ball, cup it move towards the goal and kick the ball to score. The team has 3 minutes to score 5 goals. Once each team has demonstrated the functionality of their device the competition begins (Figure 3). Two teams compete in a soccer match for 5 minutes. Teams are eliminated on a knock out basis until the final two teams remaining compete for the overall title. Each team must complete a final project report and this is handed in during week 12.

Figure 3: Competition Day and Robot Soccer Match

TEACHING AND ASSESSMENT

No formal exam takes place in this module although a number of assessments and assignments must be completed. These include completed workshop projects, poster and presentation assignments and a final team report. The class is addressed as a whole at the beginning of each activity and also attend scheduled lectures. There is also considerable staff input through informal group discussions. Feedback is given in a timely manner and this encourages a good working relationship between staff and students. A web site has also been developed for this module where class material, timetables, archive material, photos of previous events, poster templates etc are available for students to used throughout the course of the module. Assessment of semester two is based on attendance, presentation skills, poster design, goals scored, a detailed engineering evaluation of the final device and the final project report. A break down of the assessment marks for semester 1 and 2 is given in Table 2.

Semester 1 Marks		Semester 2 Marks	
Plane Fabrication	10	Design and Build Quality	30
Concepts Presentation	10	Poster and Goals Scores	15

Speed Control Board	5	Final Report	30

Table 2: Assessment marks for semester 1 and 2.

An issue highlighted regularly with group work is that of passengers and early dropouts within the group. This issue is addressed using attendance sheets, group mentors, staff feedback to module coordinators and student feedback. The objective is to highlight lack of attendance as early as possible and to initiate mentor/staff intervention at an early stage. Lack of contribution within any group is not tolerated and groups are encouraged to device workplans for each group member. Self regulation of the group is encouraged over staff intervention. However, if required, mentors and staff will intervene.

The level of participation, team work and general enjoyment and competition within this module is exceptional. Staff regularly comments on their under-estimation of student's ability and the interest in problem solving and a high level of engagement within this module. Students do not see this module as a 'just to pass the exam module'. They can work towards a given goal with limited information and an opportunity to learn, play and express themselves within there work. They can explore different ideas and designs and have the ability to show case their work to a wide audience. Group work encouraged early in the 1st semester forges life long relationships and has resulted in high success rates in this module.

The learning outcomes achieved on completion of this module include:
1. The solving of practical engineering problems using basic scientific knowledge
2. The use computer packages to write technical reports, create spreadsheets, make presentations and publish work
3. Use computer aided design (CAD) applications to create engineering drawings.
4. Use IT skills and software for learning, sourcing and presentation of material.
5. The ability to plan and complete a project on time.
6. The ability to work effectively within a team to achieve a desired objective

RESOURCES AND LOGISTICS

Initial set up costs for this module required that a new workshop area be designed and equipped in the school of electronic engineering and that an old workshop facility in the school of mechanical and manufacturing engineering be reequipped to facilitate this new module. However once this initial expenditure on tooling was spend in year one limited reequipping of each facility was subsequently required. The same was true of initial purchases of kits for the robot build as a number of components can be reused on a yearly basis. The overall cost of tools and kits for year one was of the order of €15,000 to accommodate 120 students.

The structure of this module required substantial staff student interaction. This includes module coordinators, academic staff, technical staff and group mentors. This contact time with students cannot be overemphasised as it can be the difference between success and failure in this module. To achieve this complex timetabling must accommodate staff interaction, lab time, mentor slots, presentations, group assessments and workshop time. It must also facilitate student and staff availability across two engineering schools. Scheduling of events, assessments and deadlines resulted in the need to develop a dedicated web site for this module which allows students to be informed of changes to timetables, groups, assessment dates etc on a daily basis.

Space lab and equipment requirements are high for this module and require flexibility from technical and support staff as these rooms are multipurpose and are used to serve other modules in 3rd and final year. In theory each lab was designed to accommodate 30 students however an average of 15 students per lab works well for both staff and students.
Other activities also have a requirement for space throughout the semester. These include space for poster and public presentations (we use the foyer of the engineering building for this) and space for the final soccer competition which takes place in the student recreation facility (the Hub).

CONCLUSIONS

The use of project based learning as an introduction to engineering for first year students at DCU has been a great success. This module has resulted in a very high level of technical output from 1st year undergraduate students and a high level of staff and student engagement. The module encourages self learning, group interaction and a high level of team work. It also forges relationships between 1st years which continue throughout the duration of their engineering degree. Students also see the relevance of engineering science and a range of other 1st year subjects in the design process and the module was found to enhance student confidence and skills

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